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REASONS FOR DESIRING A BETTER CLASSIFICATION OF THE UREDINALES.*

BY J. C. ARTHUR.

There are two especially prominent reasons for the consistent naming of the species of rusts, and for other plants as well. One is to be able to designate each particular kind as desired by using an authoritative name, and the other is to indicate the relationship which that kind holds to other kinds according to its recognized place in a natural system. If we examine the classification of the Uredinales now in use from these two standpoints, passing by for the present other points of view, many defects will be apparent, even to the verge of thorough confusion.

The methods by which an authoritative name may be selected, when more than one has been in use, have been much discussed of late and need not be taken up here. When the general rules of nomenclature are applied to the Uredinales, however, a complication arises in many cases due to the fact that some of the species possess partly or wholly independent phases of existence during their life cycle; and these different phases have such nearly equally prominent characteristics that they were at first inevitably placed in separate genera, as if they were autonomous organisms. When the different forms of a species are collected under one name, it would seem natural and logical that the several appellations previously in use for the different phases of the species should have consideration. Yet the view, that only names applied to the last or telial stage of the species are worthy of recognition, is held by many uredinologists. A discussion of this topic can not be taken up here, but it may be worth while to state the opinion of the writer that when the real significance of the several life phases of the rusts is better appreciated the opposition to a logical treatment of the Uredinales in conformity with the treatment of other plants will largely, if not wholly disappear. In support of this opinion let it be noted that those who would discredit the nomenclatorial standing of the aecial phase are in the anomalous position of ignoring the sexual stage of the species, if we are to accept recent cytological studies, which in the case of other plants is considered the pivotal basis of classification.

In passing to the second part of the subject it is worth bearing in mind that the desire for a stable nomenclature should never stand in the way of improvement in classification by segregation of genera to bring out more clearly the relationship of groups of species. One of the impediments at the present time to an understanding of the interrelationship of rusts lies in the lack of reasonable segregation of genera. In support of this statement one need only recall the fact that the genus *Puccinia* as now consituted contains more than half of all known species of rusts, and what may not be so well known, that within this category are contained groups of the most diverse forms and affinities. To be assigned to this genus requires only that the rust shall possess a two-celled, stalked teliospore. No consideration need be given to the nature of the spore wall, whether homogeneous or differentiated into well marked layers, or to the number and position of the germ pores in each cell, or to the question of simple or compound stalks. It is also unnecessary to ask whether the life cycle of the rust possesses pycnia, aecia and uredinia, in addition to the telia, or whether one or more of these is wanting, or what may be the origin of sori in any or all of these four stages in relation to the substratum. Yet all these characters, and some others, should be kept in mind to rightly appreciate the validity of a genus in the *Uredinales*. In short the genus *Puccinia* is founded upon what is essentially a single character, which can not be shown to be correlated with other characters going to form a natural grouping of closely related organisms. A very similar genus is that of *Uromyces*, which differs from *Puccinia* apparently only in possessing one-celled instead of two-celled teliospores, and all that has been said of *Puccinia* aplies with equal force to *Uromyces*. These two genera are fine examples of the heterogeneous results of founding genera on a single technical character when it can not be shown to be also a representative character.

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Let us now turn from the negative to the positive side of the discussion, and instead of insisting upon the artificial construction of the genera *Puccinia* and *Uromyces*, let us see what segregation can be made of the species to show more fully their affinities. First of all it will be necessary to study more fully than is usual both spores and sori of all the stages or phases of each species, including the pycnia. Our attention will soon be attracted to the fact that while the pycnia of the majority of species are flask shaped, and arise under the epidermis, some are conical or flat, and arise under the cuticle. We shall further find that these differences are correlated with characters in the other spore forms, especially in the spores and sori of the uredinia and the spores of the telia.

Removing now all species with subcuticular pycnia, and directing attention more particularly to the uredinia of this segregated group, we shall find species in which the urediniospores are distinctly different at apex and base, reminding one of the urediniospores of the genus *Ravenelia*. Correlated characters will be found to set aside a group of genera having be-side the peculiar urediniospores also teliospores with verrucose, globoid cells and fascicled pedicels, for which *Puccinia Pruni-spinosae* is a good illustration, and still another group of genera having teliospores borne one or more on free pedicels, and the spores often flattened above and below, for which *Uromyces brevipes,* the rust on *Rhus,* is representative.

Having removed these groups of genera related to *Ravenelia* we shall still have left species with urediniospores of the usual appearance, but with sori surrounded by numerous paraphyses. Among these we shall find a group of genera with peculiarly tuberculate teliospores having lateral germ pores, clearly related to *Phragmidium,* and still another group of genera in which the teliospores possess a hygroscopic layer between the outer and inner parts of the wall, clearly related to *Uropyxis.* This latter group is still further separable into genera with lateral pores like *Uropyxis,* or with apical pores like species of *Puccinia* having subepidermal pycnia.

Having now removed a large number of species from the parallel genera *Puccinia* and *Uromyces,* and segregated them into groups of genera related variously to *Ravenelia, Phragmidium* and *Uropyxis,* let us look at what remain, all of which have flask-shaped pycnia arising from beneath the epidermis. We can easily discover here two groups of genera, one having indefinitely extended aecia and colorless teliospores, germinating in the sorus as a rule, of which *Puccinia evadens* found on *Baccharis* is a representative, and the group of genera having definite aecia and colored teliospores, embracing all that is left of the genera *Puccinia* and *Uromyces,* of which most grass and sedge rusts, *Puccinia Helianthi,* etc., are representatives.

Having now segregated the species usually placed under *Puccinia* and *Uromyces* into seven groups of genera with affinities extending through the whole length of the *Pucciniaceae,* let us resolve these several groups into their respective genera. In order to do this it is necessary to take a glance at the probable scope of the influences which have determined the development of the genera in the *Uredinales.* It seems highly probable that in general the influences which have acted to limit and shape the species and also the genera of higher plants, such as temperature, humidity, elevation, natural barriers, succession of seasons, etc., have also had similar effects upon the species of the rusts. In addition to these a set of influences have been brought to bear by virtue of their strict parasitism, which are scarcely to be paralleled in any other group of plants. This is shown in limiting the species to certain orders, genera, or even species of hosts. How far the host has reacted upon the rust to modify its form and structure is difficult to decide, but that such action has occurred there seems to be no occasion for doubt. This influence of the substratum in the case of parasitic plants, however, is doubtless largely comparable with the influence of the substratum in non-parasitic plants, only more pronounced.

But there is an influence which has helped to delimit both species and genera among the *Uredinales*, not found apparently in any other group of plants. This influence is difficult to define, but it is manifested in directing the phylogenic course of development within the group, by which the life-cycle is shortened.

There appears to be ample justification in assuming that at a comparatively early period in the evolution of the *Uredinales* all the rusts possessed four forms of spore-structures, pycnia, aecia, uredinia and telia. We need not go back of this period to inquire how they came to have the four kinds of spores, as it does not affect in the least our present contention. But during the universally four-spored condition for the order, some influence began to affect the relative production of the several spore-forms, which eventuated in the suppression of one or more of these from certain species or group of species. As a result of this influence we find that the *Uredinales* of the present day consist of groups of species in the several divisions of the order, generally regarded as genera, which in many cases can be again separated into at least four groups of species, according as they possess all spore-forms, all but aecia, all but uredinia, or finally only telia. In each of these four groups the pycnia are generally present, but in some species of the last named group even pycnia may fail.

Among the melampsoraceous rusts there has been an unpremeditated, and largely unrecognized tendency to regard the absence of certain spore-forms as among valid generic characters, but among the pucciniaceous rusts such a tendency is distinctly opposed. That this is, however, a generic character of importance among rusts generally, I not only venture to affirm, but believe that it will in many cases be found to be associated with other characters further indicating true generic grouping. It is among the genuine *Pucciniae* after other genera have been removed as indicated above, that this character for separating genera finds its most uniform and conspicuous application. This is in fact exactly what should be expected, for this group undoubtedly represents the highest and most complex development of the *Uredinales*.

In advocating the importance of recognizing the life-cycle in drawing generic distinctions it is well to forestall misapprehension by pointing out that the usual absence of a spore-form does not necessarily constitute an abbreviated life-cycle. Many species of rusts in northern regions especially have the habit of propagating themselves from year to year largely by the urediniospores which survive the winter, either as continuously produced spores on living leaves, as in the case of *Puccinia Poarum* and *P. rubigo-vera,* or as stray spores no longer connected with a living host, as in *P. Sorghi* and *P. graminis.* In such cases the uredinia are usually followed each season by a greater or less development of telia, which serve little or no purpose in the propagation of the species, as the proper host plants for the aecia may be rare or absent. Such a condition explains the great prevalence of such species as *Coleosporium Solidaginis* and *Melampsora Medusae* when suitable coniferous hosts do not occur within hundreds of miles, and their aecia are rarely or never collected. Again in warmer regions a species is maintained through its urediniospores alone, the other spore-forms rarely or never being seen. But these are not instances of abbreviated life-cycle within the meaning here implied. They are a form of extended conidial propagation, the full life-cycle, whenever circumstances permit it to be completed, showing all spore-forms. In other cases the completed life-cycle may show less than the full number of spore-forms, as in *Puccinia umbelliferarum,* where the aecia are wanting, etc.

While every genus heading a large section of the *Uredinales,* like *Coleosporium, Melamspora,, Cronartium, Ravenelia, Phragmidium,* etc., is theoretically capable of division into four genera in accordance with the extent of the life-cycle, yet forms are not known in all cases to permit of such a division, and no uniformity exists in regard to the proportional number of species falling into each of the newly delimited genera. Moreover, in many cases other characters demand recognition, and altogether it will be found that the admission of the life-cycle as a generic character does not result in a mathematical regularity of genera, throughout the order, as at first sight might be assumed.

If we require that a genus should represent as fully as possible a group of organisms giving evidence of having been derived from the same ancestors, and therefore with species more closely related genetically to one another than to those of any other genus, it becomes necessary to explain a well known parallelism, brought to our attention by Fischer of Switzerland. He showed that in many cases the teliospores of a species having an extremely abbreviated life-cycle, *e. g. Puccinia Leucanthemi,* closely resemble in structure those of an autoecious species, *e. g. P. Aecidii-Leucanthemi,* in which the host of its aecia is the same or practically so as the host of the abbreviated species. Tranzschel has successfully applied this rule of parallelism in predicting the host of the unrecognized aecia in certain heteroecious species. In such cases of parallelism there can be no doubt that the forms in question have truly descended from a common ancestor, but dating a long way back, even to the early days when all the rusts had four spore-forms. Searching for an adequate cause to account for the breaking up of a primitive species into two or more modern parallel species with different lengths of life-cycle, I think it may be found in the augmented influence of parasitism. In the primitive times the rusts were doubtless but weakly parasitic, but in their onward development parasitism with its restricting and reducing effects became constantly more pronounced. To develop the theory here would extend this article beyond reasonable limits, but it is believed to fully account for the observed parallelism. It also accounts for the fact that essentially the same shortening of the life-cycle occurs or may be looked for in every group of the *Uredinales,* but is most extensive in the groups showing the greatest differentiation and highest development. And finally it does not militate in the opinion of the writer against the validity of genera whose ultimate distinction is that of the length of the life-cycle, but lends important aid in tracing their relationships.

The arguments in this article have in the main been directed against or received their support from the old-time genus *Puccinia* and its consort *Uromyces,* believing that whatever would prove acceptable to systematists in this connection can readily be extended to the whole order of the *Uredinales.* I have thus presented some of the reasons which appeal to me for desiring a better classification of the *Uredinales,* believing that when obtained it will promote the study of the order and facilitate an understanding of relationships.

NORTH AMERICAN SPECIES OF LEPIOTA.

A. P. MORGAN.

The name LEPIOTA was given by Persoon to the first section of his genus *Agaricus;* it had a wider application in the "Synopsis" than is assigned to it in the genus of the same name at the present time. Fries in the "'Systema" made of the term Lepiota a tribal designation, restricting it to the species of Agaricus about as understood at present. The species thus included are well worthy of generic distinction.

Fries in the Hymenomycetes Europaei enumerates 45 species of Lepiota. Since the publication of this volume (1874) European mycologists have increased the number to more than 100. The region most prolific in species of this genus so far discovered is the island of Ceylon where upward of 70 species were enumerated and described by Berkeley and Broome. Sacardo in the different volumes of the Sylloge Fungorum enumerates more than 300 species.

Schweinitz in the North American Fungi (1834) gives a list of 5 species of Lepiota. In Lea's Catalogue (1849) there is a